Physical Education and its Effect on Elementary Testing Results

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Abstract

This study was designed to determine the impact of increased quality Physical Education time on Massachusetts Comprehensive Assessment System (MCAS) standardized scores. The MCAS test was given to 311 fourth-grade students in two Southeastern communities in Massachusetts, within a two-month period in April and May of 2001. The participants were tested in two areas, English and Language Arts (ELA), and Math. The literature review examined the cognitive and physical benefits of movement, physical activity and exercise. Brain-based learning and the relationship of physical education and academic performance were analyzed. Results of the study revealed that the mean ELA MCAS score for School 1 and the mean ELA MCAS score for School 2 were significantly different. The mean Math MCAS score for School 1 and the mean Math MCAS score for School 2 revealed no significant difference. In conclusion, students who received more hours of quality physical education per school year scored higher in the ELA subject area of the MCAS standardized test.

The function and development of the mind is influenced by the health and care of the body. Van Dalen and Bennett (1971) stated that:

> For in everything that men can do the body is useful, and in all uses of the body it is of great importance to be in as high a state of physical efficiency as possible. Why, even in the process of thinking, in which the use of the body seems to be reduced to a minimum, it is a matter of common knowledge that grave mistakes may often be traced to bad health ...But a sound and healthy body is a strong protection to a man (p.61).

Research and experimental studies beginning in the 1950's through the 1990's show that exercise and physical activity programs are justified and needed because of their physical benefits. The 1990's have been referred to as the "decade of the brain" (Jensen, l998b). In the past few years, the cognitive sciences have seen a great deal of activity in the development of theories that use biological processes to explain complex cognitive functions (Jensen, 1998b). Technology has paved the way for neuroscientists with brain scanners like Magnetic Resonance Imaging (MRI), Positron Emission Tomography (PET), and Nuclear Magnetic Resonance Imagery (NMRI) (Jensen, 1998b). Prior to this new technology, animal studies and examination of the post mortem human brain were used for brain analysis.

With the influx of this new information regarding brain research, educators must decide who is credible and who is not. More applied research is needed, rather than more application of learning theories. Howard Gardner's Theory of Multiple Intelligences is a good example of the over application of an educational theory. Gardner's Theory has enormous implications for educators if used as Gardner intended. However, if it is used as an educational solution or as a quick fix to a problem, Gardner's Theory of Multiple Intelligence may be misused. Brain research is here to stay and educators have a professional responsibility to examine the research and utilize the information for application within the classroom. Teaching strategies, discipline policies, the arts, special education, curriculum, technology, bilingual programs, music, learning environments, staff development, assessment, and organizational change are some of the areas that educators may be able to apply brain research.

Children have become more sedentary with the development of computer and video game technology. As a result of this increasingly inactive lifestyle, more American children are overweight than in any other generation (U.S. Department of Health and Human Services, 1997). Effects of this sedentary lifestyle on the health of children is demonstrated by an increase in both Type II Diabetes and arteriosclerosis (Tremblay, Inman, & Willms, 2000). The need for support for increased exercise has never been greater. Research has shown that exercise provides more oxygen-rich blood, which nourishes the brain. More neurotransmitters are released, more endorphins are released, and more neural networks are developed with movement (Jensen, 1998a).

Research indicates that physical activity enhances brain function and produces many cognitive and physiological benefits (Diamond, 1998; Hannaford, 1995; Jensen, 1998a; Sylvester, 1995). Children who are provided with many experiences at an early age develop an abundance of neurons and are better learners. When these learning opportunities are not provided, the connections are not made and learning is not enhanced. Whole-brain learning through movement repatterning, or learning to move in new ways, can help students to access those parts of the brain previously unavailable to them.

Movement is a vital aspect of the brain's ability to cognitively function. The relationship between motor and intellectual performance is strongest at very early stages of development. A physical education program that provides a wide-variety of developmentally appropriate activities and experiences to children can have profound results on academic achievement.

Although there have been many studies devoted to the benefits of physical fitness and activity (Calfas & Taylor, 1994; Diamond, Krech, & Rosenzweig, 1964; Etnier et al., 1997; Herholz et al., 1987; Kirkendall, 1986; Myotin, 1990), there are many who believe that physical education is dispensible (Blaydes, 2001). The question remains as to the impact of movement on brain function with regard to academic learning and achievement. If exercise does in fact promote brain function and impact cognitive function, all educators must be concerned with the possibility of the reduction or total elimination of physical education programs within school districts. The results of this research study help to support the belief that students who receive more hours of physical education each week should score higher on the standardized tests than those students who received less hours.

This study provided an overview of brain-based learning and the human brain. Also, current and past research was presented in the area of physical activity and academic achievement. The area of assessment was reviewed with specific emphasis on the Massachusetts Comprehensive Assessment System (MCAS) test and the objectives of this assessment tool currently used in Massachusetts. Lastly, the area of the influences and implications of physical education and the need for quality physical education programs was presented. Although the educational applications of much of this brain research are not yet clear, it is critical for all educators to acquire a scientific understanding of brain mechanisms. Without this knowledge base, educators may not be able to be as actively involved in the decision-making process; ultimately having a profound effect on students.

Method

The purpose of this study was to statistically analyze the means of the standardized test scores of fourth-grade students in two different schools. Each school had different hours of quality physical education per school year. The standardized test examined was the MCAS. The test was administered in the spring of 2001. The test scores analyzed were the Mathematics, and the English and Language Arts (ELA) scores. Scaled scores that ranged from 200 to 280 were used, and there were four performance levels, which included advanced (260-280), proficient (240-259), needs improvement (220-239), and warning (200-219). Scaled score results provided more precise feedback because they described a student's performance on the continuum of scores within the performance levels.

An independent t-test design was employed to determine if a significant difference existed between MCAS scores in fourth-grade students when physical education time was greater. The independent variable was physical education time per school year, with two levels. School 1 provided students with 28 hours of physical education each year. School 2 provided students with 56 hours of physical education each year. The dependent variable was the individual students' MCAS scores in both School 1 and School 2. Data were statistically calculated and the means of the scores were determined and compared. A p value of $< .05$ would indicate a significant statistical difference between the means of School 1 and School 2.

The profiles and comparisons of schools within the districts of School 1 and School 2 were examined. The district for School 1 has a total enrollment of 2,204 students. The district for School 2 had a total enrollment of 4,019 as of June 2000. The race/ethnicity percentages were somewhat different. School 1 had 6.4% Native American students, 4.6% African American students, 0.8% Asian students, 1.7% Hispanic students, and 86.5% Caucasian students. School 2 had 0.2% Native American students, 0.6% African American students, 0.5% Asian students, 0.3% Hispanic students, and 98.4% Caucasian students. Per pupil expenditures for School l's district were $5,857 for all day programs, $4,870 for regular education, and $9,975 for special education. Per pupil expenditures for School 2's district were $4,586 for all day programs, $4,236 for regular education, and $5,572 for special education. The average teacher's salary in School l's district was $40,284 and $44,639 for School 2's district. School 1's district had a drop-out rate of 3.3% and School 2's dropout rate was 1.2%. The district's attendance rate for School 1 was 94.6% and the attendance rate for School 2's district was 95.8% (Massachusetts Department of Education, 2000).

Upon closer examination of the two towns per pupil expenditures, it is important to note that between the years of 1997 to 1999, School 1's district had an increase in per pupil expenditure. In the all-day programs, the expenditure increased by approximately $800 in the all-day programs and a $600 increase in the regular education area. A $1400 increase in the special education area was noted. Even with the increases in each area, School 1's district was still below the state's average of per pupil expenditure. Conversely, in School 2's district, the per pupil expenditure decreased by approximately $600 in the all day programs and decreased approximately $100 in the regular education area. There was also a decrease by almost $5000 in the special education area. The district for School 2 was also below the state's average of per pupil expenditure.

As part of the Commonwealth's 1993 Education Reform Law, the Chapter 70 school aid formula had attempted to expand the state's role in financing local public schools and ensure that every school district had adequate funding regardless of the wealth of the community. Struggling urban communities with low income and property wealth would now equal the state average in per pupil spending. These changes benefited many communities in the state, but also failed to factor in enrollment growth, inflation, the fiscal demands of special education and also educational technology. Communities that had considerable growth in their districts were unable to keep up with the state's average per pupil expenditure. Also, many rural towns lack a large commercial base to help ease the local property tax burden. The Chapter 70 formula is currently under revisions with a new five-year plan. It is attempting to provide all communities in Massachusetts with educational funding adequacy and equity.

Participants

The participants in this study consisted of a convenience sample of 311 male and female fourth-grade students. The participants were between 9 and 11 years old. All participants were required to take the *WAS* standardized test. The participants completed a written survey and consent of the survey was not needed in either school district. However, both the students and parents had prior knowledge of the survey and could request not to participate. All 311 participants completed this survey.

Both schools are located in Southeastern Massachusetts. School 1 has approximately 600 students in grades four, five and six, with 207 fourth-grade students within this building. School 2 has approximately 1100 students in kindergarten through eighth-grade. There are 104 fourth-grade students within this school. A survey was administered to these students in December of 2001 to determine whether or not any of the students had received any specific instruction relative to the MCAS test. Students were questioned about their level and frequency of physical activity. A component of this survey was to distinguish between physical education activity within the school day, and extra-curricular activities after school. It was determined that both School 1 and School 2 had similar physical education curriculums. The specific units of instruction examined were from January through May of 2001. Both physical education teachers had approximately 14 years of teaching experience in the public school system.

Procedures

The participants were required to take the *MCAS* standardized English and Language Arts (ELA), and Mathematics test within a two-month time period in April and in May of 2001. A written survey was completed by the participants during the school day. School 1 returned 193 surveys and School 2 returned 113 surveys.

Statistical Analysis

The results obtained for the dependent variable of ELA and Mathematics scores were analyzed using the Independent Samples t-test for the dependent variable MCAS scores. The independent variable was physical education time per school year, with two levels. The participants in School 1 had 28 hours of physical education per school year in 2001, and the participants in School 2 had 56 hours of physical education in 2001. Statistical significance was accepted at $p < 0.05$, and all analyses were performed using the Statistical Package for Social Sciences (SPSS 11.0).

Results

The independent t-test of the ELA scores comparing the means of School 1 and School 2 revealed a significant difference between the means of the two groups ($p=.00$). The mean scores are presented in Table 1. The effect size (ES) of 2.2 is a large value, which indicates that the treatment (hours of physical education) had an effect on ELA scores at School 2. The mean ELA MCAS score for School 1 and the mean ELA MCAS score for School 2 were significantly different, $t\,(309) = 1.645$, $p < .05$. The independent t-test of the Math MCAS scores comparing the means of School 1 and School 2 revealed no significant difference. The means of the two groups, $t = .158$, Table $t\,(309) = +\,1.645$, $p > .05$. The effect size (ES) was calculated to be 0.1, which is a low value, indicating that the treatment (hours of physical education) did not have an effect on the math scores.

The 2001 ELA and MATH test scores revealed that school 1 had an overall average of 43% in the Proficient and Advanced Level for the ELA test scores. This is lower than the state average of 51% for Grade 4 students. School 2 had an overall average of 61% in the Proficient and Advanced Level for the ELA test scores, which is higher than the state average of 51%. School 1 had an overall average of 33% in the Proficient and

Advanced Level for the Math test scores. This is slightly below the state average of 34% for Grade 4 students. School 2 had an overall average of 43% which is above the state average of 34% for Grade 4 students.

Table 1

Independent Samples t-Test Results for English and Language Arts MCAS Scores for School 1 and School 2.

	School 1		School 2			
MCAS test	M	SD	M	SD	df	t( )
ELA	235.62	12.69	240.94	11.47	309	-3.59***
Math	235.56	14.61	238.02	14.10	309	-1.41

*p<.05. *** p<.001.

Discussion

This research was designed to determine whether or not more hours of quality physical education time per week had an impact on MCAS test scores. The test scores from two areas in School 1 and School 2 were analyzed. The directional hypothesis used in this study stated that students who received more hours of physical education would score higher on the MCAS test.

The major finding of this study was that the students in School 2, who received more hours of physical education than the students in school 1, scored significantly higher on the ELA test. The significance level of the t-test was .00 (p<.05); therefore the null hypothesis has been rejected. The students in School 2 who received more hours of physical education did not score significantly higher on the Math test than the students in School 1. The significance level of the t-test was .158 (p> .05); therefore the null hypothesis cannot be rejected.

Students who participated in after-school team sports and/or individual physical activities were of similar percentages in both schools. The hours of tutoring students received in both schools were also of similar percentages, as were the levels of activity that each student described for him/herself.

The purpose of the student survey was to identify any influences that may affect the student's MCAS test scores. The number of students that took the MCAS tests in School 1 was 207, and the number of surveys received from School 1 was 193. The final n for the survey was 186; 7 surveys were not used as these students were not students enrolled in that school at the time of the test (April-May 2001). The number of students who took the MCAS tests in School 2 was 104, and the number of surveys received from School 2 was 113. The final n for the survey was 107; 6 surveys were not used as these students were also not enrolled at that school during the time of the MCAS test. The reason for these differences in surveys and number of test scores can be attributed to students moving into and out of school districts before or after the testing period.

In conclusion, this study can provide useful information to educators and administrators who are faced with difficult decisions regarding program reduction if the elimination of physical education is considered, due to the need of increasing daily academic time to help increase test scores. This study has shown that students who receive more hours of physical education can score higher on certain subject areas of the MCAS test. Quality physical education programs must be given equal time in every student's educational plan. Each community must receive appropriate proportional educational funding from the state government so that each district receives equal per pupil expenditure. Standardized testing continues to be a critical measure of student academic performance. MCAS test is here to stay and so should quality physical education programs.

Further research studies to collaborate with this study might include analyzing the MCAS scores of different grade levels (6, 8, 10) and comparing the results of the two studies. Also, a longitudinal study of the fourth-grade students at School 1 and School 2 might reveal interesting and valuable results. Several communities have drastically reduced or eliminated physical education programs therefore a comparison of the MCAS scores before and after such a reduction would be an important and useful study. Lastly, an examination in which one class within one school would receive extra hours of physical education or exercise before and during the MCAS testing periods while the other class receives none might provide further relavant data. The mean MCAS scores of the two groups would be examined to determine whether or not the treatment (hours of physical education) had an effect on the MCAS scores.

The MCAS test is a relatively new measure of assessment. There are many studies on academic achievement and assessment, but very few studies have specifically looked at the MCAS test. Furthermore, an examination of the relationship that exists between hours of physical education and MCAS scores is virtually nonexistent. More research studies need to be completed with a specific focus on quality physical education programs and increased MCAS standardized test scores. In a political and economic climate in which physical education programs are rapidly being eliminated from academia, it would be valuable for physical educators to relate the information presented in this article with administrators in an effort to support their programs.

REFERENCES

Blaydes, J. (2001) Advocacy: A case for daily quality physical education. *Teaching Elementary Physical Education,* 12(3), 9-12.

Calfas, K., & Taylor, W. (1994). Effects of physical activity on physiological variables in adolescence. *Pediatric Exercise Science* 6(4), 406-423.

Diamond, M., Krech, D., & Rosenzweig, M. (1964). The Effects of an enriched environment on the rat cerebral cortex. *Journal of Comparative Neurology,* 123, 111-119.

Diamond, M. (1998). *Enriching heredity: The impact of the environment on the anatomy of the brain.* New York: The Free Press.

Etnier, J., Han, M., Landers, D., Nowell, P., Petruzzello, S., & Salazar, W. (1997). The influence of physical fitness and exercise upon cognitive functioning: A meta-analysis, *Journal of Sport & Exercise Psychology,* 19, 249-277.

Hannaford, C. (1995). *Smart moves-why learning is not all in your head*. Arlington: Great Ocean.

Herholz, K., Buskies, B., Rist, M., Pawlik, G., Hollman, W., & and Heiss, W. (1987). Regional cerebral blood flow in man at rest and during exercise, *Journal of Neurology,* 234, 9-13.

Jensen, E. (1998a). *Teaching with the brain in mind.* Alexandria: ASCD Association for Supervision and Curriculum Development.

Jensen, E. (1998b). *Introduction to brain-compatible learning.* San Diego: The Brain Store.

Kirkendall, D. (1986). Effects of physical activity on intellectual development and academic performance, *Effects of Physical Activity on Children.* American Academy of Physical Education Papers No. 19.

Massachusetts Department of Education (2000). FY 00 per pupil expenditures, Retrieved from: http://www.doe.mass.edu

Massachusetts Department of Education (2000). Profile pages, Retrieved from: http://www.doe.mass.edu

Massachusetts Department of Education (2001). Chapter 70 Local Aid Formula, Retrieved from: http://www.doe.mass.edu.

Massachusetts Department of Education (2001). Overview of the MCAS 2001 Tests, Retrieved from: http://www.doe.mass.edu.

Myotin, E. (1990). Movement experiences and academic achievement, *Sport and Physical Activity,* London

Madras, E. & Ratey, J. (2001). *A user's guide to the brain: Perception, attention, and the four theaters of the brain,* Boston, MA: Pantheon.

Sylwester, R. (1995). *A celebration of neurons-an educator's guide to the human brain,* Alexandria: ASCD-Association for Supervision and Curriculum Development.

Tremblay, J., Inman, J., & Willms, J. (2000). The relationship between physical activity, self-esteem, and academic achievement in 12-year old children, *Pediatric Exercise Science,* 12, 312-323.

U.S. Department of Health and Human Services (1997). *Promoting lifelong physical Activity,* Atlanta, GA: Centers for Disease Control (CDC).

Van Dalen, D., & Bennett, B. (1971). *A world history of physical education: Cultural, philosophical, comparative*. Englewood Cliffs, NJ: Prentice-Hall. VanPraag, H. (1999). Running boosts number of brain cells. Retrieved from: http://www.salk.edu.

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